

## CLAIMS

What is claimed is:

1. An asymmetric Group 8 (VIII) metallocene of the general formula CpMCp',  
5 where

M is a metal selected from the group consisting of Ru, Os and Fe;

Cp is a first substituted cyclopentadienyl or indenyl moiety that includes at least one substituent group D<sub>1</sub>;

Cp' is a second substituted cyclopentadienyl or indenyl moiety that includes at least one substituent group D<sub>1</sub>';

10 wherein

D<sub>1</sub> is different from D<sub>1</sub>';

D<sub>1</sub> is selected from the group consisting of:

X;

15 C<sub>a1</sub>H<sub>b1</sub>X<sub>c1</sub>;

C<sub>a2</sub>H<sub>b2</sub>X<sub>c2</sub>(C=O)C<sub>a1</sub>H<sub>b1</sub>X<sub>c1</sub>; and

C<sub>a2</sub>H<sub>b2</sub>X<sub>c2</sub>OC<sub>a1</sub>H<sub>b1</sub>X<sub>c1</sub>,

where

X is F, Cl, Br, I or NO<sub>2</sub>;

20 a1 is an integer from 2 to 8;

b1 is an integer from 0 to 2(a1)+1 - c1;

c1 is an integer from 0 to 2(a1)+1 - b1;

b1 + c1 is at least 1;

a2 is an integer from 0 to 8;

25 b2 is an integer from 0 to 2(a2) + 1 - c2;

c2 is an integer from 0 to 2(a2) + 1 - b2; and

D1' is selected from the group consisting of:

X;

C<sub>a1</sub>H<sub>b1</sub>X<sub>c1</sub>;

$C_{a2}H_{b2}X_{c2}(C=O)C_{a1}H_{b1}X_{c1}$ ; and

$C_{a2}H_{b2}X_{c2}OC_{a1}H_{b1}X_{c1}$ ,

where,

X is Fl, Cl, Br or I or  $NO_2$ ;

5

a1 is an integer from 1 to 8;

b1 is an integer from 0 to  $2(a1)+1 - c1$ ;

c1 is an integer from 0 to  $2(a1)+1 - b1$ ;

b1 + c1 is equal to or greater than 1;

a2 is an integer from 0 to 8;

10

b2 is an integer from 0 to  $2(a2)+1 - c2$ ;

c2 is an integer from 0 to  $2(a2)+1 - b2$ ; and

b2 + c2 is equal to or greater than 1.

2. The asymmetric metallocene of Claim 1 wherein either or both of  $Cp$  and  $Cp'$

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includes at least one additional substituent,  $D_x$ , selected from the group consisting of:

X;

$C_{a1}H_{b1}X_{c1}$ ;

$C_{a2}H_{b2}X_{c2}(C=O)C_{a1}H_{b1}X_{c1}$ ;

20

$C_{a2}H_{b2}X_{c2}OC_{a1}H_{b1}X_{c1}$ ;

$C_{a2}H_{b2}X_{c2}(C=O)OC_{a1}H_{b1}X_{c1}$ ; and

$C_{a2}H_{b2}X_{c2}O(C=O)C_{a1}H_{b1}X_{c1}$ ,

where,

X is Fl, Cl, Br or I or  $NO_2$ ;

25

a1 is an integer from 0 to 8;

b1 is an integer from 0 to  $2(a1)+1 - c1$ ;

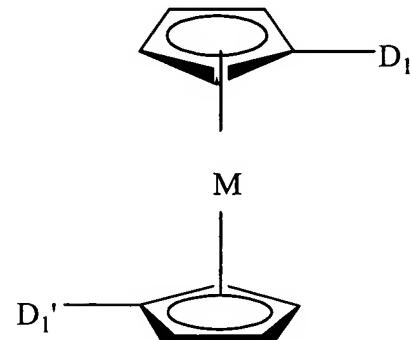
c1 is an integer from 0 to  $2(a1)+1 - b1$ ;

b1 + c1 is equal to or greater than 1;

a2 is an integer from 0 to 8;

b2 is an integer from 0 to  $2(a2)+1 - c2$ ;  
 c2 is an integer from 0 to  $2(a2)+1 - b2$ ; and  
 b2 + c2 is greater to or equal to 1.

5 3. A metallocene compound represented by the following molecular formula:



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where

M is selected from the group consisting of Ru, Os and Fe;

D1 is different from D1' and D1 and D1' are independently selected from the group consisting of:

X;

15

$C_{a1}H_{b1}X_{c1}$ ;

$C_{a2}H_{b2}X_{c2}(C=O)C_{a1}H_{b1}X_{c1}$ ; and

$C_{a2}H_{b2}X_{c2}OC_{a1}H_{b1}X_{c1}$ ,

where

X is F, Cl, Br, I or  $NO_2$ ;

20

a1 is an integer from 1 to 8;

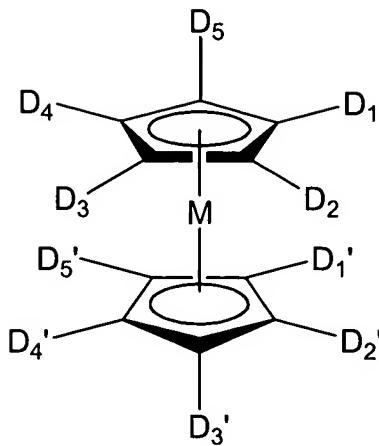
b1 is an integer from 0 to  $2(a1)+1 - c1$

c1 is an integer from 0 to  $2(a1)+1 - b1$ ;

$b1 + c1$  is at least 1;

a2 is an integer from 0 to 8;  
b2 is an integer from 0 to  $2(a2) + 1 - c2$ ; and  
c2 is an integer from 0 to  $2(a2) + 1 - b2$ .

- 5 4. The metallocene compound of Claim 3, wherein D<sub>1</sub> is methyl and D<sub>1</sub>' is selected from the group consisting of ethyl, propyl, isopropyl, n-butyl, sec-butyl and tert-butyl.
5. The metallocene compound of Claim 3, wherein D<sub>1</sub> is ethyl and D<sub>1</sub>' is selected from the group consisting of propyl, isopropyl, n-butyl, sec-butyl and tert-butyl.
- 10 6. The metallocene compound of Claim 3, wherein D<sub>1</sub> is propyl and D<sub>1</sub>' is selected from the group consisting of isopropyl, n-butyl, sec-butyl and tert-butyl.
7. The metallocene compound of Claim 3, wherein D<sub>1</sub> is isopropyl and D<sub>1</sub>' is selected from the group consisting of n-butyl, sec-butyl and tert-butyl.
- 15 8. The metallocene compound of Claim 3, wherein D<sub>1</sub> is n-butyl and D<sub>1</sub>' is selected from the group consisting of sec-butyl and tert-butyl.
9. The metallocene compound of Claim 3, wherein D<sub>1</sub> is sec-butyl and D<sub>1</sub>' is tert-butyl.
- 20 10. A compound of the general formula,



where  $D_1$  and  $D_2$  are different and each is independently selected from the group consisting of:

5  $C_{a1}H_{b1}X_{c1};$   
 $C_{a2}H_{b2}X_{c2}(C=O)C_{a1}H_{b1}X_{c1};$  and  
 $C_{a2}H_{b2}X_{c2}OC_{a1}H_{b1}X_{c1}.$

where

10            X is F, Cl, Br I or  $\text{NO}_2$ ;

          a1 is an integer from 1 to 8;

          b1 is an integer from 0 to  $2(a1)+1 - c1$

          c1 is an integer from 0 to  $2(a1)+1 - b1$ ;

$b1 + c1$  is at least 1;

          a2 is an integer from 0 to 8;

15            b2 is an integer from 0 to  $2(a2) + 1 - c2$ ;

          c2 is an integer from 0 to  $2(a2) + 1 - b2$ ; and

          each of  $D_2$ ,  $D_3$ ,  $D_4$ ,  $D_5$ ,  $D_2'$ ,  $D_3'$ ,  $D_4'$ , and  $D_5'$  is independently selected from the group consisting of:

          X;

20             $\text{C}_{a1}\text{H}_{b1}\text{X}_{c1}$ ;

$\text{C}_{a2}\text{H}_{b2}\text{X}_{c2}(\text{C}=\text{O})\text{C}_{a1}\text{H}_{b1}\text{X}_{c1}$ ;

$C_{a2}H_{b2}X_{c2}OC_{a1}H_{b1}X_{c1}$ ;  
 $C_{a2}H_{b2}X_{c2}(C=O)OC_{a1}H_{b1}X_{c1}$ ; and  
 $C_{a2}H_{b2}X_{c2}O(C=O)C_{a1}H_{b1}X_{c1}$ ,

where,

5            X is F, Cl, Br, I or NO<sub>2</sub>;  
          a1 is an integer from 0 to 8;  
          b1 is an integer from 0 to 2(a1)+1 - c1;  
          c1 is an integer from 0 to 2(a1)+1 - b1;  
          b1 + c1 is equal to or greater than 1;

10           a2 is an integer from 0 to 8;  
          b2 is an integer from 0 to 2(a2)+1 - c2;  
          c2 is an integer from 0 to 2(a2)+1 - b2;  
          b2 + c2 is equal to or greater than 1.